

What is claimed is:

1. A three-dimensional volumetric display system comprising:  
a microlens array; and  
an electrical control device that controls a depth position of individual volume  
5 points of a 3D volumetric image.
2. The display system of claim 1 wherein said electrical control device controls a  
focal length of individual microlenses within said microlens array to control said position  
of said individual volume points.
3. The display system of claim 2 wherein said electrical control device comprises an  
adjustable voltage.  
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4. The display system of claim 2 wherein said microlens array comprises a plurality  
of liquid crystal microlenses.
5. The display system of claim 4 wherein said microlens array is configured for  
passive matrix drive addressing.
- 15 6. The display system of claim 4 wherein said microlens array is configured for  
active matrix drive addressing.
7. The display system of claim 4 wherein said plurality of liquid crystal microlenses  
comprises a plurality of asymmetric liquid crystal microlenses.
8. The display system of claim 7 wherein each of said asymmetric liquid crystal  
20 microlenses includes one hole-patterned electrode.
9. The display system of claim 8 wherein said hole-patterned electrode is an  
aluminum hole-patterned electrode.

10. The display system of claim 7 wherein each of said asymmetric liquid crystal microlenses includes one indium tin oxide electrode.
11. The display system of claim 4 wherein said plurality of liquid crystal microlenses is a plurality of symmetric liquid crystal microlenses.
- 5 12. The display system of claim 11 wherein each of said symmetric liquid crystal microlenses includes two hole-patterned electrodes.
13. The display system of claim 12 wherein at least one of said hole-patterned electrodes is an aluminum hole-patterned electrode.
14. The display system of claim 4 wherein said plurality of liquid crystal microlenses  
10 each have a diameter from about 100 to about 500 microns.
15. The display system of claim 4 wherein said plurality of liquid crystal microlenses each have a cell thickness from about 50 to about 200 microns.
16. The display system of claim 2 further comprising a LCD flat panel superposed with said microlens array.
- 15 17. The display system of claim 16 wherein the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding pixel in said LCD flat panel.
18. The display system of claim 2 further comprising an other microlens array superposed with said microlens array, said other microlens array being a passive  
20 microlens array.
19. The display system of claim 18 wherein the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding microlens in said other microlens array.

20. The display system of claim 19 having a range of focal lengths from about 1 to about 100 mm.
21. The display system of claim 19 wherein said microlens array and said other microlens array are positioned such that a real three-dimensional image is generated.
22. The display system of claim 19 wherein said microlens array and said other microlens array are positioned such that an imaginary three-dimensional image is generated.
23. The display system of claim 2 further comprising:
- a LCD flat panel; and
- a other microlens array, wherein said other microlens array is a passive microlens array;
- wherein said microlens array, said other microlens array and said LCD flat panel are superposed with one another;
- wherein the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding microlens in said other microlens array and with the optical axis of the corresponding pixel in said LCD flat panel.
24. A three-dimensional volumetric display system comprising:
- a variable focal length microlens array, said microlens array including a plurality of liquid crystal microlenses; and
- an electrical control device, wherein said electrical control device controls a focal length of individual microlenses within said microlens array, said electrical control device including an adjustable voltage.

25. A method for displaying a three-dimensional volumetric image comprising:

projecting an image through a display system, said display system including a microlens array; and

electrically controlling a position of individual volume points of said volumetric image by means of an electrical control device.

26. The method of claim 25 wherein said electrical control device controls a focal length of individual microlenses within said microlens array.

27. The method of claim 26 wherein said electrical control device comprises an adjustable voltage.

28. The method of claim 26 wherein said microlens array comprises a plurality of liquid crystal microlenses.

29. The method of claim 28 wherein said microlens array is configured for passive matrix drive addressing.

30. The method of claim 28 wherein said microlens array is configured for active matrix drive addressing.

31. The method of claim 28 wherein said microlens array comprises a plurality of asymmetric liquid crystal microlenses.

32. The method of claim 28 wherein said microlens array comprises a plurality of symmetric liquid crystal microlenses.

33. The method of claim 28 wherein said plurality of liquid crystal microlenses each have a diameter from about 100 to about 500 microns.

34. The method of claim 28 wherein said plurality of liquid crystal microlenses each have a cell thickness from about 50 to about 200 microns.
35. The method of claim 26 wherein said three-dimensional volumetric image is projected through said microlens array by means of a LCD flat panel, said LCD flat panel  
5 being superposed with said microlens array.
36. The method of claim 35 wherein the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding pixel in said LCD flat panel.
37. The method of claim 26 wherein said display system further comprises a other  
10 microlens array superposed with said microlens array, said other microlens array being a passive microlens array.
38. The method of claim 37 wherein the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding microlens in said other microlens array.
- 15 39. The method of claim 38 wherein said display system has a range of focal lengths from about 1 to about 100 mm.
40. The method of claim 38 wherein said microlens array and said other microlens array are positioned such that a real three dimensional image is generated.
41. The method of claim 38 wherein said microlens array and said other microlens  
20 array are positioned such that an imaginary three-dimensional image is generated.
42. The method of claim 26 wherein:  
said image is projected through said microlens array by means of a LCD flat panel, said LCD flat panel being superposed with said microlens array;

said display system further comprises a other microlens array, wherein said other microlens array is a passive microlens array;

said microlens array, said other microlens array and said LCD flat panel are superposed with one another;

- 5        the optical axis of each microlens in said microlens array is coincident with the optical axis of the corresponding microlens in said other microlens array and with the optical axis of the corresponding pixel in said LCD flat panel.